Thermophysical Properties of Some Medicinal Plant Leaves Readily Available In the North East India

M.N. Bora

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2. Metallurgy Division, National Institute of Standards and Technology, Gaithersburg, Maryland 20899, U.S.A.

3. Guest scientist from: Department of Physics, Gauhati University, Guwahati, Pin-781014, Assam, India.

4. To whom correspondence should be addressed.

   Prof. M.N. Bora

   Professor and Head of Physics Department

   Gauhati University, Guwahati-781014, Assam, India

   Fax: 91-0361-570133, E-mail:kkhigu @ gw1.dot.net.in

ABSTRACT

The thermophysical properties of untreated,quenched and annealed medicinal plant leaves: Mahaneem (Azadiracta Indica), Tulsi (Ocimum Sactum) and Nefafu (Cierodendrum Colefroo-kianum) readily available in North-East India, specially available in Assam have been investigated under different conditions by thermo-Gravimetry (TG), Derivative Thermo-Gravimetry (DTG) and Differential Thermal Analysis (DTA) methods in air, oxygen and nitrogen atmospheres in the temperature range 300-680K.

The thermograms have shown that all the medicinal plant leaves undertaken in the present investigations are hydrophilic in nature. Two thermal reaction steps are attributed by the samples on the temperature ranges 328-360 K and 553-730K. There is no significant variation of these points for all samples in air, nitrogen and oxygen atmospheres. The first transition peak has been revealed the dehydration of the water molecules from the semi-crystalline hosts. The second endothermic peak has confirmed the irreversible dissociation of the crystallites.

The weight losses, activation energies and change of entropies of activation at the dehydration and decomposition steps have been computed for all samples. No significant variation of the kinetic parameters has been observed in air, oxygen and nitrogen atmospheres.

Key Words:

Activation Energy, Decomposition, Dehydration, Entropy, Hydrophilic, Weight loss.

1. INTRODUCTION

The medicinal plant leaves: Mahaneem (Azadiracta Indica) Tulsi (Ocimum Sactum) and Nefafu (Cierodendrum Colefrookianum) readily available in North East India are organic polymers. The thermophysical studies of these leaves have great importance in medical applications. It has been found that many attempts were made to study the thermal behaviours of various polymeric materials [1…4]. Investigations of thermophysical properties of silk and plant fibres have been made by some investigators [5…8]. The evaluation of kinetic data from thermogravimetry (TG), derivative thermogravimetry (DTG) and differential thermal analysis (DTA) have been critically reviewed by some workers [9…14]. In our earlier work, the thermal properties of some medicinal plant leaves have been studied by differential Scanning Calorimetry (DSC) [15]. In the present investigation, three medicinal plant leaves: Mahaneem (Azadiracta Indica), Tulsi (Ocimum Sactum) and Nefafu (Clierodendrum Colefrookianum) were taken to study the thermophysical properties by TG, DTG and DTA methods.

2. MEASUREMENTS

2.1. Specimens

The medicinal plant leaves: Mahaneem, Tulsi and Nefafu were collected from different places of North East India. They were dried and processed for various laboratory works by the techniques described elsewhere [15]. They were divided into three portions. The first portion was annealed and the second portion was quenched upto 425 K. These annealed, quenched and unheated samples were used for the thermal measurements.

2.2 Procedure

The recordings of TG and DTG of the medicinal plant leaves were carried out with a Perkin-Elmer thermal analyser under operated heating rate of 10Kmin^{-1} in air, oxygen and nitrogen atmospheres with a flow rate of 30cm min^{-1} in the temperature range 302-730 K. The calibrations of TG and DTG sensors were also checked with an inert sample to remove base line errors. The DTA records of the samples were performed using the same arrangements described elsewhere [16]. All thermogram records of each sample were repeated twice from room temperature to 450 K to check the reproducibility. They were almost superimposed on each other. The thermograms were measured accurately by calibrating them in terms of centimeteres with the help of a Norelco travelling microscope of uncertainity ± 0.001 cm.

3.RESULTS

The TG and DTG thermograms of the medicinal plant leaves are shown in Figure 1. The figure represents the records of TG and DTG as the plot of percentage weight loss versus temperature of the three medicinal plant leaves: Mahaneem (A), Tulsi (B) and Nefafu (C). All thermograms show almost a similar nature. The TG curves show the beginning of weight loss at 321, 325 and 328 K for the samples A,B and C respectively. This process continues upto the temperature about 352K for the samples. This stage of TG thermograms is represented by the first endothermic peak in DTG curves. From the first step of TG and DTG thermograms, it is evident that the heat is absorbed by the medicinal plant leaves to remove the water molecules, which were mostly embeded in the amorphous region of semicrystalline leaves. During the process, the structural setup remains unaltered as indicated by the return of the DTG thermograms to the base

line. This was also proved by earlier X-ray diffraction study made for plant fibres [14]. The rapid fall of TG curves and the second endothermic peaks in the DTG thermograms at the temperature range of about 505-608 K indicate irreversible decompositions of the organic molecules associated in the structure.

The DTA thermograms of unheated samples annealed and quenched samples upto 425 K are displayed in the Figure 2. Each of DTA thermograms shows one endothermic and one exothermic peak almost in the same temperature ranges as shown by TG and DTG curves. The endothermic peak corresponds to dehydration and the exothermic peak represents the decomposition stage. It is evident from the Figures 1 and 2 that the TG and DTG results are in agreement with the DTA data within the limitation of the instruments.

In addition to air atmosphere, the TG, DTG and DTA thermograms of the medicinal plant leaves were recorded in the oxygen and nitrogen atmospheres. The kinetic reaction data summerised from the records of the TG, DTG and DTA records are shown in the Table I. The three medicinal plant leaves show almost

identical thermal behaviours in the three media: air, oxygen and nitrogen. No significant variation of thermophysical parameters is obtained in oxygen and nitrogen atmospheres at dehydration and decomposition stages. The activation energy (E) required to activate the thermal reactions in the medicinal plant leaves at dehydration and decomposition stages was computed by the use of TG data on the basis of

differential equation of Freeman Carroll [9]. From the DTG peak temperature, the activation energy and hence the change of entropy (Δs) were computed on the basis of the modified Freeman and Carroll method, used by earlier workers to study the thermal decomposition of some polymeric compounds [4]. The results are displayed in the Table II.

The activation energies computed from TG and DTG curves yield almost similar values. These values are slightly higher in oxygen atmosphere and smaller in the nitrogen atmosphere than that in air atmosphere. The change of entropy (Δs) for the three medicinal plant leaves is almost the same.

The gases thus evolved in the decomposition stage are due to thermal degradation and they are traced as water vapour, carbon dioxide and carbon monoxide. This is in agreement with the IR spectroscopic investigation, as described elsewhere [17]. In air and oxygen atmospheres, the weight loss in decaying stage is attributed. This may be due to formation of carbon dioxide and carbon monoxide by the process of oxidation, whereas in nitrogen atmosphere, no such oxidation takes place, and as a result, the decaying stage was not observed.

4.CONCLUSION

All three medicinal plant leaves used in present investigations are hydrophilic in nature.. The first transition points of the thermograms of the leaves represent the dehydration process. The process involves the dessociation of water molecules mostly embeded in the amorphous region of the semi crystalline medicinal plant leaves. The second transition stages of the thermograms represent the thermal decomposition and

degradation of crystalline setup of the leaves. No significant variation of thermal activities in different atmospheres (air,oxygen and nitrogen) has been observed for any of these leaves. The similar thermal behaviours possessed by these medicinal plant leaves make their constituents suitable to behave similar metabolic reactions with organisms of living beings.

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Table I. TG, DTG and DTA data under different media (Air, O_2, N_2)

Sample	Medium	Step	TG data		DTG data		DTA data		Reac.
			Temp. Range (K)	Weight Loss (%)	Temp. Range (K)	Peak Temp. (K)	Temp. Range (K)	Peak Temp. (K)	-tion
Maha Neem (A)	Air	1	302-360	5.2	305-362	345	304-366	340	Dehy
		2	503-603	30.3	509-610	553	510-612	560	Decom
		3	690-730	15.0	689-724	701	688-719	701	Decay
Tulsi (B)	Air	1	305-361	6.2	309-365	348	307-342	338	Dehy
		2	514-601	40.2	516-606	556	506-603	557	Decom
		3	689-728	15.2	688-723	699	689-709	699	Decay
Nefafu (C)	Air	1	308-358	5.9	309-359	332	303-361	338	Dehy
		2	502-601	33.2	503-602	550	503-606	552	Decom
		3	689-730	14.4	690-799	702	689-799	699	Decay
Maha Neem	O_2	1	306-362	5.8	309-363	342	309-362	343	Dehy
		2	501-603	31.3	502-604	551	507-618	558	Decom
		3	688-729	15.6	699-720	698	689-719	699	Decay
Tulsi	O_2	1	306-364	7.0	308-364	346	307-369	339	Dehy
		2	514-603	39.2	515-603	552	515-611	554	Decom
		3	699-724	14.8	690-720	701	689-708	699	Decay
Nefafu	O_2	1	302-360	6.3	302-362	348	304-362	341	Dehy
		2	517-660	37.3	517-670	551	512-610	563	Decom
		3	687-720	15.4	695-719	710	687-701	699	Decay
Maha Neem	N_2	1	311-367	4.9	312-362	350	313-368	345	Dehy
		2	509-607	31.2	309-602	552	510-609	560	Decom
Tulsi	N_2	1	311-367	5.1	312-366	349	314-361	340	Dehy
		2	510-610	35.2	512-612	553	516-612	561	Decom
Nefafu	N_2	1	308-362	4.7	310-363	344	312-365	346	Dehy
		2	512-612	30.2	514-613	554	515-614	561	Decom

Dehy-Dehydration, Decom-Decomposition, Decay-Decaying

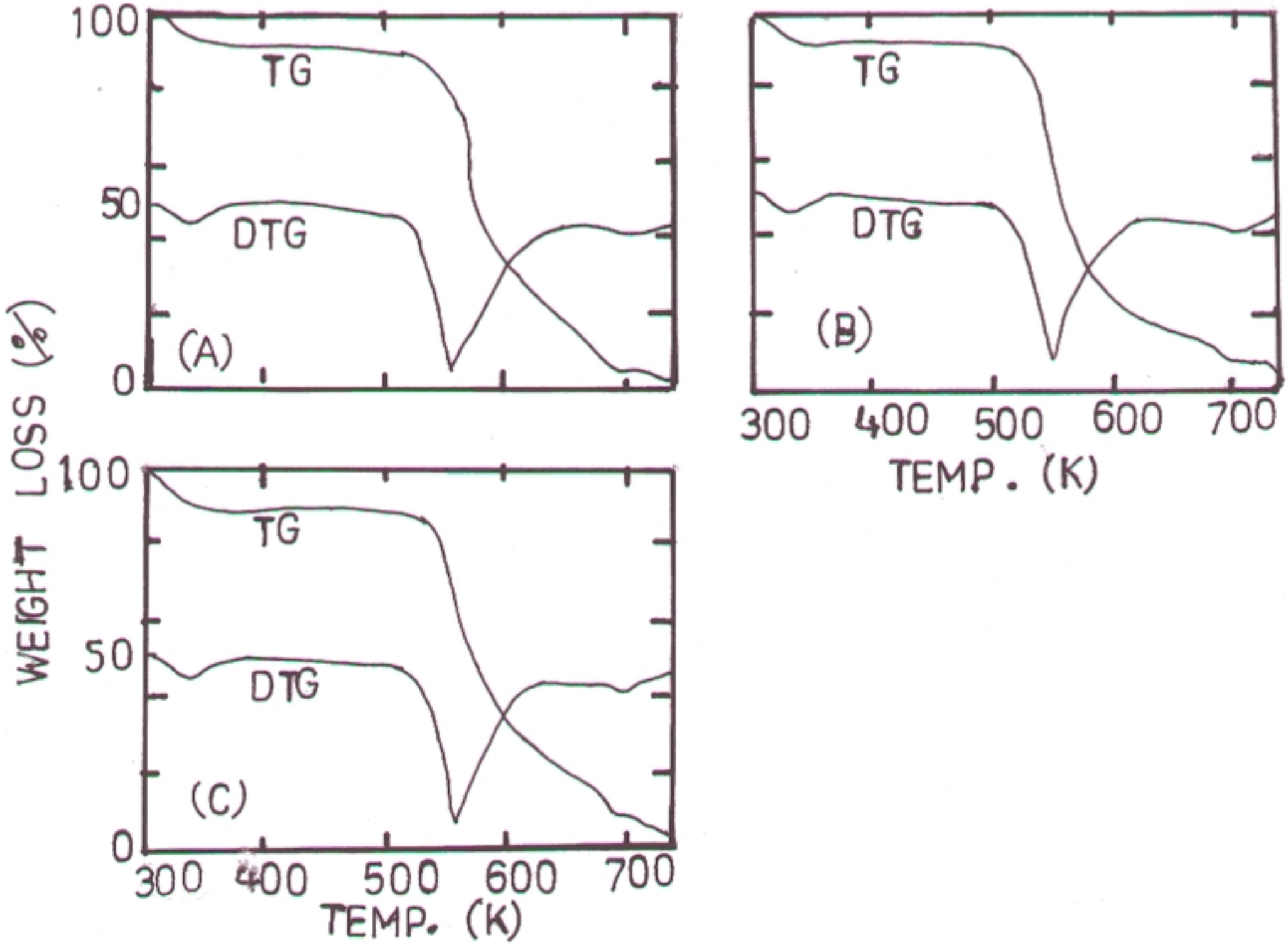
Table II. Activation energy (E) and Change of entropy (ΔS) computed from TG and DTG thermograms in air, oxygen and nitrogen atmospheres

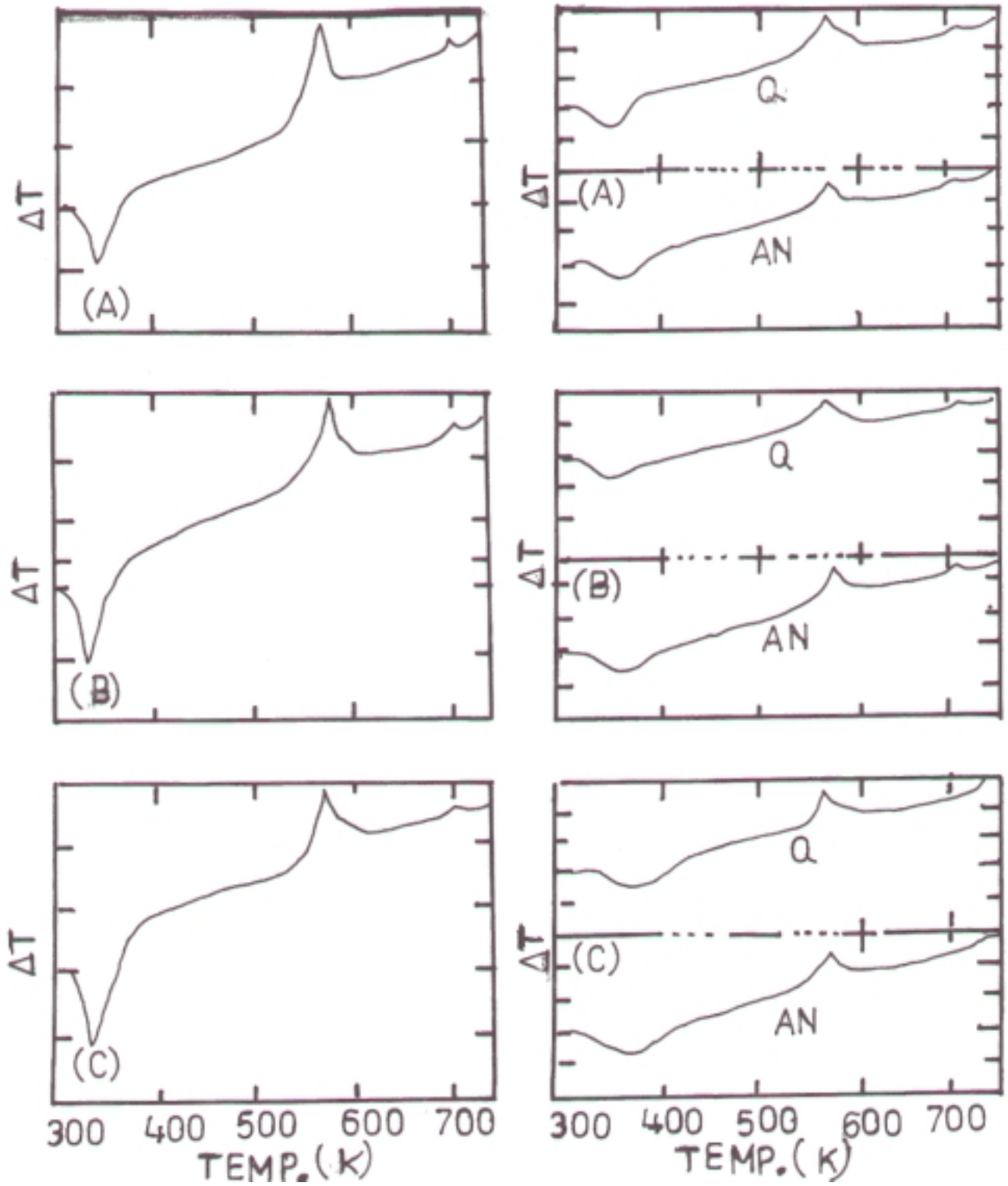
Sample	Step	Air medium		Oxygen medium		Nitrogen medium	
		E (KJ mol^{-1})	Δs (e.u.)	E (KJ mol^{-1})	Δs (e.u.)	E (KJ mol^{-1})	Δs (e.u.)
Maha	1	15.28	-142.61	16.92	-159.21	13.21	-140.18
Neem	2	38.41	-162.22	38.51	-168.38	36.82	-152.31
Tulsi	1	13.81	–143.46	14.20	-147.65	12.23	-140.23
	2	37.23	–160.51	38.13	-163.21	36.12	-156.24
Nefafu	1	14.32	- 144.23	14.82	-141.45	13.02	-143.28
	2	36.47	-161.65	38.25	-168.28	35.91	-160.51

FIGURE CAPTIONS

Fig. 1. TG and DTG thermograms in air : (A) Mahaneem (Azadiracta Indica), (B) Tulsi: (Ocimum Sactum) and (C) Nefafu (Cierodendrum Colefrookianum).

Fig.2. DTA thermograms of (A) Mahaneem; (B) Tulsi and (C) Nefafu in air: U = Unheated; Q = Quenched and AN = Annealed Sample.


100
50
0
TG
DTG
(A)
(B)
(C)
WEIGHT LOSS (%)
300
400
500
600
700
TEMP. (K)


ΔT
(A)
Q
(A)
AN
ΔT
(B)
Q
(B)
AN
ΔT
(C)
Q
(C)
AN
300 400 500 600 700
TEMP.(K)
300 400 500 600 700
TEMP.(K)